Green Synthesis Of Titanium Dioxide Nanoparticles From The Aquous Extract Of *Pterocarpus dalbergioides* Leaves And Their Anti Diabetic Activity

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ABSTRACT

The field of nanotechnology is the most effective and active area of research in modern materials science. Though there are many chemicals as well as physical methods, green synthesis of nanomaterials is the most emerging method of synthesis. We report the green synthesis of titanium dioxide nanoparticle using leaves of medicinal herb *Pterocarpus dalbergioides*. *Pterocarpus dalbergioides*, often known as Andaman Padauk, is an indigenous tree to India's Andaman Islands. We extracted the leaves of *Pterocarpus dalbergioides* using aqueous solution. We have characterized using UV, FTIR, XRD and SEM/EDAX analysis. The anti-diabetic activity by alpha amylase assay and alpha glucosidase assay was performed. The leaves of *Pterocarpus dalbergioides were found to have anti-diabetic activity.*

Keywords: *Pterocarpus dalbergioides*, Titanium Dioxide, SEM, Anti-Diabetic

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INTRODUCTION

Pterocarpus dalbergioides

The tree *Pterocarpus dalbergioides* is part of the Fabaceae family. The Bay of Bengal is a native place. Andaman padauk is a deciduous tree that grows up to 30 meters in height. The tree's bark is brown and smooth. The leaves are compound, with 5 to 9 leaflets that are oblong in shape and about 10 to 15 centimeters long. The flowers are small and yellow, and the fruit has one or two seeds.

A species of plant called *Pterocarpus dalbergioides* is a member of the legume family Fabaceae. It is indigenous to tropical and subtropical regions of South and Southeast Asia, including India, Sri Lanka, Myanmar, Thailand, Laos, Cambodia, Vietnam, and Indonesia. It is also known as the East Indian Rosewood or the Andaman Padauk.

Pterocarpus dalbergioides is mostly found in Assam, Manipur, Andaman & Nicobar Islands and Nagaland in northeastern India, as well as in sliver populations in West Bengal, Bihar, and Odisha. It is a deciduous tree with a 30-meter height that is prized for its fine wood, which is frequently used for furniture, flooring, musical instruments, and decorative items.

The wood of *Pterocarpus dalbergioides* is very attractive and durable. It can be used to make furniture, decorative items and musical instruments. The tree has many therapeutic properties. The Andaman padauk is considered an endangered species due to habitat loss and over-exploitation for its valuable timber. The tree species is being protected.

The state tree of A & N Islands is the Andaman Redwood, which is native to the Andaman Islands.This legume plant belongs to the Fabaceae family and is often referred to as the Andaman padauk, Andaman redwood, or East Indian mahogany. The term "narra" is occasionally used to refer to it, however this is only a general term for any Pterocarpus species.

May through July are the flowering months. The huge, buttressed Andaman Redwood (*Pterocarpus dalbergioides*) is a deciduous to semi-deciduous tree. The bark's inside is reddish, flaky, thick, and flaky, and it peels off in erratic scales. The 5–9 ovate–lance-shaped, alternate leaflets have a tapering tip, and the leaves are alternate, pinnately complex, imparipinnate, and pulvinate. Yellow, tiny flowers are produced in panicles at branch and leaf axil ends. Fruit is a flat, elongated, wing-like pod with a long stalk. Pod does not split open, has a single kidney-shaped seed **(Partha Mondal & Surekha T. Landge.,2019)**.

***Pterocarpus dalbergiodes* Leaf & Pod**

TAXONOMIC CLASSIFICATION

Kingdom: Plantae (Plants)
Subkingdom: Tracheobionta (Vascular plants)
Superdivision: Spermatophyta (Seed plants)
Division: Magnoliophyta (Flowering plants)
Class: Magnoliopsida (Dicotyledons)
Subclass: Rosidae
Order: Fabales
Family: Fabaceae (Pea family)
Genus: *Pterocarpus*
Species: *Pterocarpus dalbergioides*

The huge tree species *Pterocarpus dalbergioides* is unique to the Andaman islands. As one of the most ornamental Indian timbers, the species has cultural significance and is deserving of preservation and cultivation since it yields a good timber.

The species dominates the island and creates 'padouk' forests, or pure stands. Almost all of the Andaman Islands' deciduous and semi-deciduous forests are home to this species. The geographic range of the species is fairly constrained. The species' estimated extent of occurrence (EOO), if present on all Andaman Islands, is 14,679 km2. The population is thought to have decreased by at least 30% over the last three generations as a result of historical timber exploitation. Although the species' logging is now closely regulated, its habitat is fragmenting. Although the species' total population number is unknown, it is believed to be in decline as a result of inadequate seed regeneration, as no saplings or seedlings have been discovered at any of the 106, 0.1 hectare sites. The tree has a lengthy lifespan and it is believed that for there to be significant regeneration, the forest needs to be disturbed. The rating for the species is Vulnerable.

Pterocarpus dalbergioides Tree

Range Description- *Pterocarpus dalbergioides* is endemic to the Andaman Islands. It occurs in both southern and northern parts of the Andamans. There are no point data records for this species but assuming it occurs across all the islands that make up the Andamans south to Little Andaman islands the species has a potential estimated extent of occurrence (EOO) of 14,679 km2. Use and Trade - This species is harvested for its valuable timber which is mostly exported to the Indian mainland. The species produces a prized redwood which is used for furniture making, joinery, inlay, flooring, tool handles, veneer, boat building and decorative features **(Prasad *et al*. 2008)**. The chief use of the timber is for decorative purposes, such as panelling, parqueting, balustrades and cabinet work. Andaman Padauk has been proposed as a Rosewood substitute in musical instrument manufacture but is not yet used very extensively due to its colour. Compared to the more common African Padauk, which is listed on CITES, Andaman Padauk is considered to have a finer texture (Terence 2010). It was also used for billiard tables, interior work in first-class railway carriages and Pullman cars. The East Indian Railway used this timber for first- and second-class carriages and even an aircraft propeller was made of this timber (Pearson and Brown 1932). It is estimated that overall timber exports for the Andamans are 75,000 m3 (Sekhsaria 2001) but the volume contributed by *P. dalbergioides* is not known. Most harvest is from wild sources and the species is also thought to be subject to illegal logging. The species is also grown as a street tree in Africa and is known to be cultivated on the mainland of India too **(Louppe *et al*. 2008)**.

Related Species

- African Padauk (*Pterocarpus soyauxii*)
- Amboyna (*Pterocarpus indicus*)
- Burma Padauk (*Pterocarpus macrocarpus*)
- Muninga (*Pterocarpus angolensis*)
- Narra (*Pterocarpus indicus*)
- Zitan (*Pterocarpus santalinus*)

Other Uses: The bark is a source of tannins. The heartwood is variable, mainly a rich crimson hue or shades of red to brown, often with darker red or blackish streaks, it is sometimes pale red or yellowish; the narrow band of sapwood is greyish. The texture is rather coarse; the grain generally interlocked; dull to lustrous; without characteristic odour or taste. The heartwood is rated as very durable and also resistant to termite attack. The wood is moderately hard; it is not difficult to saw and machine but because of interlocked grain does not dress to a smooth finish; it turns well; takes a good polish. It is used for light to heavy construction, joists, rafters, beams and interior finish. It is also used to make high quality furniture, panelling, musical instruments, high-grade cabinet work, interior joinery, billiard tables, decorative flooring, agricultural implements, veneer, etc Because it withstands weathering, wearing and insect attacks, it is used for bridges, piles, posts, railway sleepers and mine timbers.

NANOPARTICLES

Particles with a size in the nanometer range—typically between 1 and 100 nanometers—are referred to as nanoparticles. The diameter of a human hair is around 100,000 times larger than one nanometer, which is one billionth of a metre in size. A wide range of physical and chemical properties are possible for nanoparticles, which can be manufactured from a number of materials including metals, ceramics, polymers, and semiconductors.

Due to their small size, nanoparticles possess special qualities such as strong reactivity, a high surface area to volume ratio, and unusual optical, electrical, and magnetic capabilities. Nanoparticles offer a wide range of applications thanks to these qualities, including drug delivery in medicine, semiconductors in electronics, and water and air filtration in environmental remediation.

However, because of their small size, nanoparticles may be more easily absorbed by cells and tissues, which could potentially have a negative impact on health. Therefore, it's critical to comprehend and reduce any potential hazards related to using and being exposed to nanoparticles.

Individual molecules are rarely referred to by the term "nanoparticle"; instead, it is typically used to describe inorganic substance. Ultrafine particles, which range in size from one to one hundred, are the same as nanoparticles. Between 100 and 2,500 nm are considered to be fine particles. The size range for coarse particles is 2,500 to 10,000 nm. Nanoparticles and ultrafine particles are often used interchangeably because, in the 1970s and 1980s, when Granqvist and Buhrman began their first comprehensive fundamental studies with "Nanoparticles" in the USA, Japan's ERATO project referred to them as "Ultrafine Particles" (UFP).

Properties of nanoparticles

A discrete nano-object with all three Cartesian dimensions smaller than 100 nm was described as a nanoparticle by the International Organisation for Standardisation (ISO) in 2008. Nanofibres and nanotubes are examples of one-dimensional nano-objects, whereas nanodiscs and nanoplates are examples of two-dimensional nano-objects as described by the ISO standard. The European Union Commission gave its approval to the definition.

a substance that contains particles in a natural, unbound state, as an aggregation, or as an agglomeration, and where at least 50% of the particles in the number size distribution have one or more exterior dimensions that fall within the range of 1 nm to 100 nm.

According to that definition, a nano-object can be classified as a nanoparticle even if none of its distinctive dimensions fall within the range of 1-100 nm. A lower limit can be obtained to get to the atomic bond lengths.

The size range originally allocated to the discipline of colloid science—from 1 to 1,000 nm—which is frequently referred to as the mesoscale—overlaps significantly with that of 1 to 100 nm. Particles are frequently described in the same way in literature. For smaller particles, there is a semantic distinction.

Nanoparticles can be divided into various categories based on their size, shape, and material characteristics. Dendrimers, liposomes, and polymeric particles are included in the first group, whereas fullerenes, quantum dots, and gold nanoparticles are included in the second. Other categories categorise nanoparticles depending on their carbon, ceramic, semiconducting, or polymeric composition. Both hard and soft particles can be categorised. Nanoparticle classification is based on both the use for which they are used and how they were made.

Nanoparticles have three main physical characteristics that are all interconnected. Nanoparticles come in a wide variety of compositions, depending on the application or product.

Nanoparticle applications in medicine

Nanoparticles in medicine have the ability to enter the body and bind to specific cells, thanks to their small size. These properties have given rise to new techniques that enhance images of different parts of the body, including organs.

They have contributed to the advancement of novel techniques for administering therapy, which involve procedures like localized heating, obstruction of blood vessels, or transportation of drugs.

Magnetic nanoparticles can be used to monitor the growth of cancer. The nanoparticles take advantage of the difference in contrast caused by the minuscule iron dioxide particles. Through hyperthermia, wherein an alternating magnetic field causes the particles to heat and damage tissue on a local scale, the particles can be utilised to kill tumours.

The usage of particles can be used to improve fluorescence photographs. The technique needs the nanoparticle to be able to identify a particular cell. A medicine could be delivered to a disease spot with the aid of targeting. The drug might be delivered in a porous structure and held in place at the desired site by bonds, enabling a gradual release of the medication. Neurological illnesses may benefit from the creation of nanoparticles to help with medicine delivery to the brain by inhalation.

TITANIUM DIOXIDE NANOPARTICLES

Nanoparticles of titanium dioxide (TiO_2) are titanium dioxide particles having a diameter of less than 100 nanometers. They are frequently utilised in many different products, including as sunscreen, cosmetics, food additives, and coatings. TiO_2 nanoparticles are helpful in a number of commercial and industrial goods due to their distinctive physical and chemical features, such as their high surface area and strong reactivity.

The potential hazards to human health and the environment posed by TiO_2 nanoparticles, however, are causing growing worry. According to some research, they may have detrimental impacts on human health, including respiratory and cardiovascular issues, as well as adverse effects on the environment, including toxicity to aquatic creatures. As a result, research is ongoing to better understand the dangers and create plans for the responsible handling and disposal of TiO_2 nanoparticles.

Nanoparticles of titanium dioxide (TiO_2) having a diameter of less than 100 nm are also known as ultrafine titanium dioxide. Due to its ability to filter UV rays while remaining transparent on the skin, ultrafine TiO_2 is used in sunscreens. Its photocatalytic sterilising properties also make it valuable as an additive in construction materials, such as anti-fogging coatings and self-cleaning windows. TiO_2 particles used in sunscreens are typically between 5 and 50 nm in size.

MATERIALS AND METHODS

COLLECTION OF SAMPLE

The *Pterocarpus dalbergioides* plant sample was collected from the place of Bambooflat, South Andaman District, Andaman & Nicobar Islands with the help of my father and my friends. The certificate of Authentication was received from Madras Botany Laboratory Herbarium, Centre for Advanced Studies in Botany, University of Madras. The Accession number is **MUBL1042**.

COLD EXTRACTION

10 gm of sample was weighed and soaked in 100 ml of sterile distilled water. The extract was allowed to stand 24h and filtered using sterile filter paper. The filtrate was collected and used for synthesis of titanium dioxide nanoparticles.

Synthesis of Titanium dioxide nanoparticles (Thakur *et al.*, 2019; Mohammad Zaki Ahmad et al., 2022)

10 ml of extract was added to 90 ml of 5 mM aqueous TiO2 solution and stirred on a magnetic stirrer at 500 rpm for 2 h at room temperature. This solution was incubated at room temperature for 6 h. After 6 hr centrifuged at 8000 rpm for 10 min. Collect the pellet and washed with

distilled water. This content was dried at 60^0 C for 1 h. This Titanium dioxide nanoparticles was stored for further analysis.

Characterization of Nanoparticles

UV–visible spectrophotometer:

UV–visible spectrophotometer was used to obtained spectral response of ZnONPs. The sample was monitored by absorbance measurements carried out on UV–visible spectrophotometer in the wavelength range of 200-800nm (Thermo Scientific—Evolution 201). It refers to absorption spectroscopy or reflectance spectroscopy in part of the ultraviolet and the full, adjacent visible spectral regions. This means it uses light in the visible and adjacent ranges. The absorption or reflectance in the visible range directly affects the perceived color of the chemicals involved. In this region of the electromagnetic spectrum, atoms and molecules undergo electronic transitions. Absorption spectroscopy is complementary to fluorescence spectroscopy, in that fluorescence deals with transitions from the excited state to the ground state, while absorption measures transitions from the ground state to the excited state.

Fourier Transforms Infrared Spectroscopy (FTIR):

Fourier-transform infrared spectroscopy (FTIR) analysis was used for the identifying the functional group of the nanoparticles. It was used to obtain an infrared spectrum of absorption or emission of a solid, liquid or gas. FTIR spectrometer simultaneously collects high-spectral-resolution data over a wide spectral range. This confers a significant advantage over a dispersive spectrometer, which measures intensity over a narrow range of wavelengths at a time. It was analysed by SHIMADZU spectrometer in the range of 500–4000 cm−1.

X-Ray Diffraction (XRD) analysis:

X-ray diffraction (XRD) is used to determine the atomic and molecular structure of nanoparticles. This method was carried out for irradiating of the material with incident X-rays and to measure the intensities and scattering angles of the X-rays which was scattered by the nano material. The X-ray beam is diffracted by the sample and detected at various angles. The XRD (RIGAKU miniflex-600, Japan) was performed using an X-ray diffractometer–Cu, Kα radiation λ 1.54 nm in the 2θ range of 30-80 operated data voltage of 40kV and a current of 30 mA. The graph is detected between 2θ in x-axis and intensity on y-axis with different peaks corresponding to different planes of the crystal.

SEM/EDAX Analysis:

Scanning electron microscopy (SEM) analyzed for the size and shape of the nanoparticles were examined. SEM provides detailed high resolution images of the sample by rastering a focused electron beam across the surface and detecting secondary or backscattered electron signal. The images of titanium dioxide nanoparticles were examined using scanning electron microscopy (SEM; TESCAN VEGA3 SBU).

ANTI-DIABETIC ACTIVITY

Inhibition of Alpha Amylase (Suhashini *et al*., 2014)

PROCEDURE

Different concentrations of samples and standard drug were taken. Then 1 ml of α-amylase in 0.2 M sodium phosphate buffer (pH 6.9) was added to each tube and was incubated at 25°C for 30 min. Then 1 ml of 1% starch solution in 0.2 M sodium phosphate buffer (pH 6.9) was added to each tube. The reaction mixtures were then incubated at 25°C for 3 min. The reaction was stopped with 1 ml of 3, 5 dinitro salicylic acid. 9 ml of distilled water was added to the reaction mixture. Absorbance was measured at 540 nm.

$$\% \text{ of alpha amylase inhibition} = \frac{\text{OD sample} - \text{OD control}}{\text{OD sample}}$$

Inhibition of Alpha Glucosidase (Elsnoussi Ali Hussin Mohamed *et al* 2012)

Procedure

100 µl of 0.1 U glucosidase was taken in different tubes. To this 50 µl of sample and standard of different concentrations were added

(should not mix) and incubated at 25°C for 10 min. Then 50 µl of p-nitrophenyl alpha- D-glucosidase was added, vortexed and incubated at 25°C for 5 min. Add 800 µl of stop solution (0.1 M sodium carbonate) was added. Absorbance was measured at 405 nm.

$$\text{\% of alpha glucosidase inhibition} = \frac{\text{OD control} - \text{OD sample}}{\text{OD control}} \times 100$$

RESULTS & DISCUSSION

The current investigation was to examine titanium dioxide nanoparticles synthesized using *Pterocarpus dalbergioides* leaves with aqueous solution **(Figure:-1 A,B and C)**.

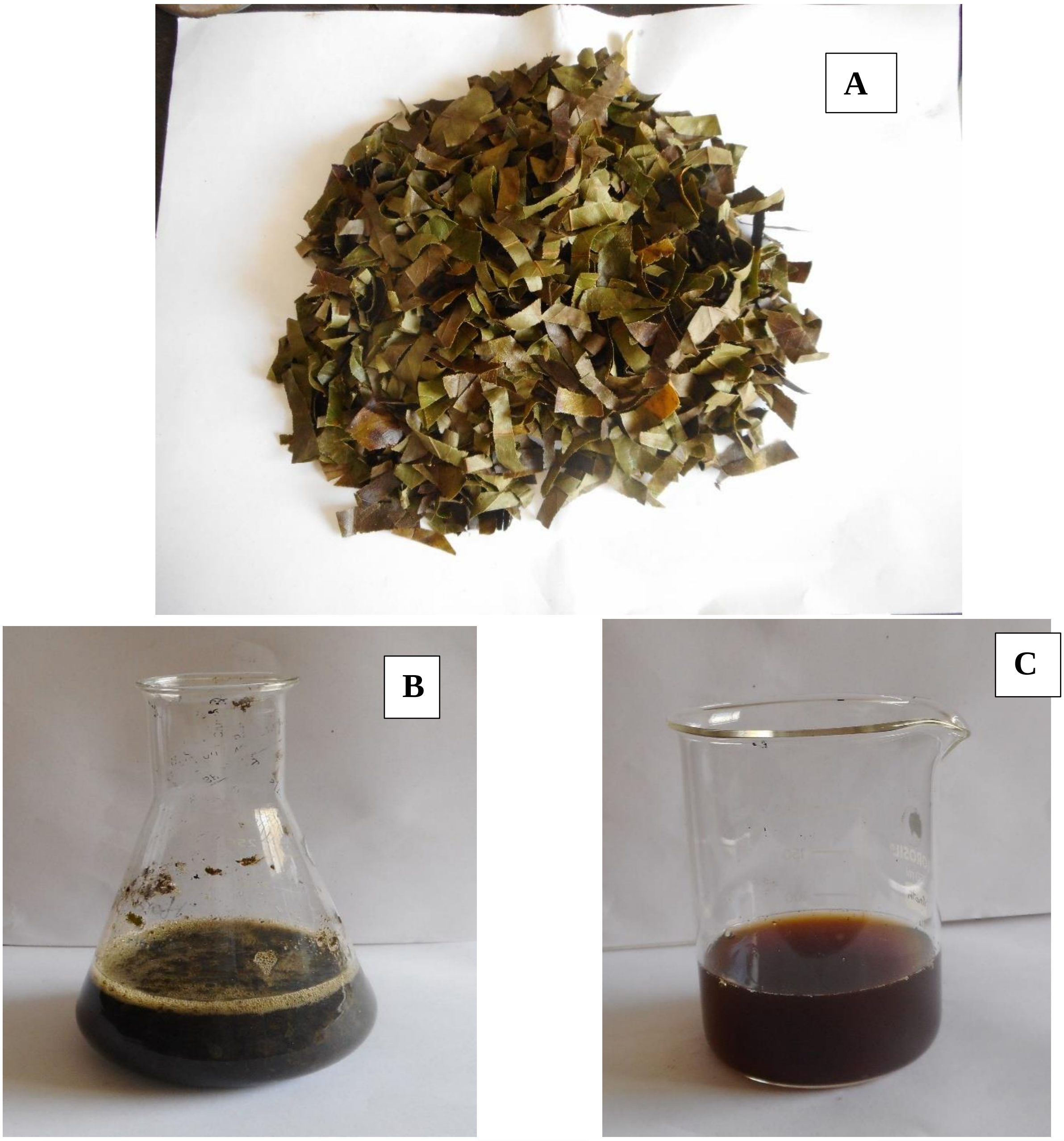

Figure 1. A. ***Pterocarpus dalbergioides*** **leaves B.** ***Pterocarpus dalbergioides*** **leaves extract C.** ***Pterocarpus dalbergioides*** **filtrate**

The colour change from white precipitate to pale yellow indicates the synthesis of titanium dioxide nanoparticles (TiO_2NPs) **(Figure 2)**.

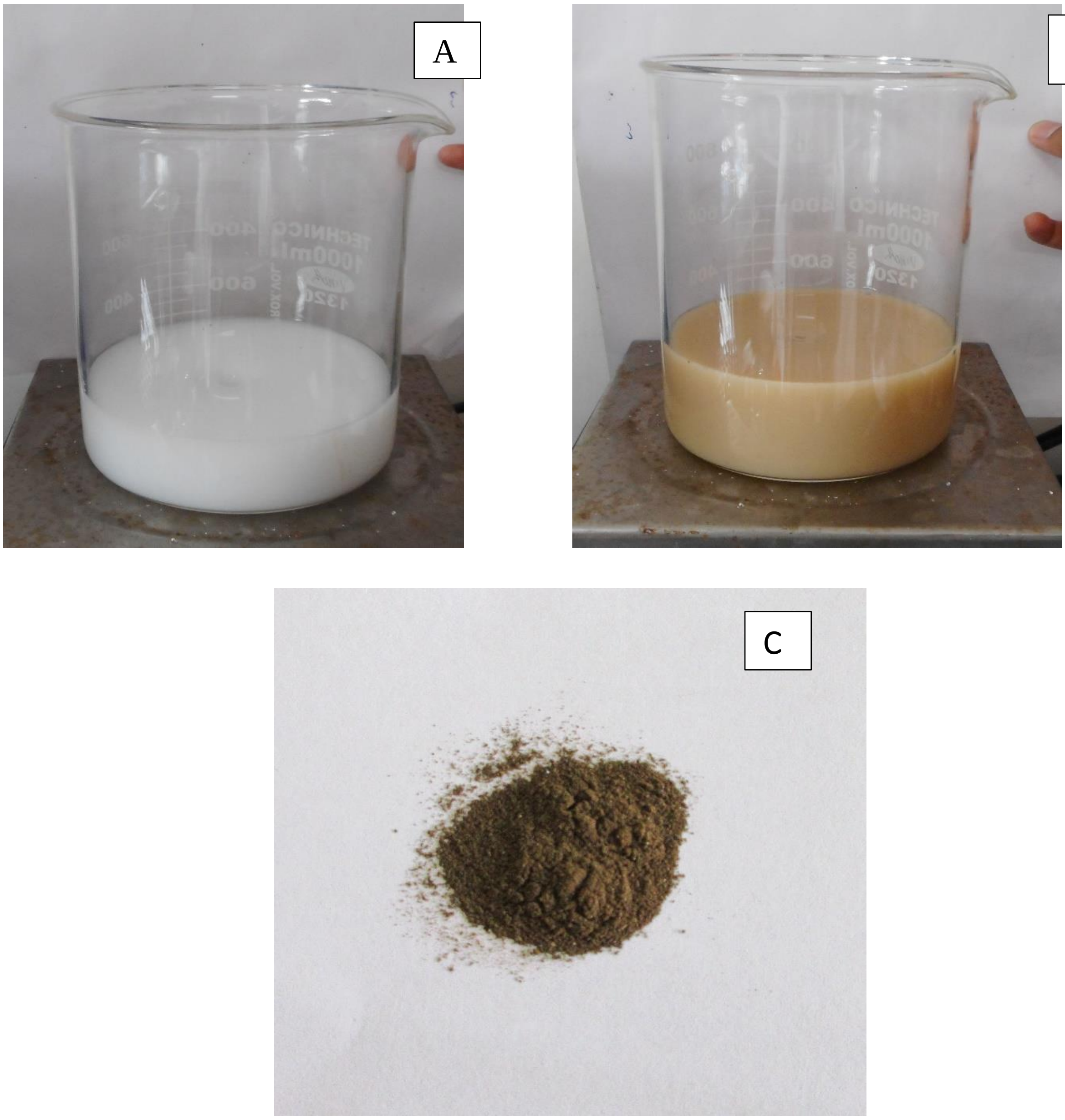

Figure2. Synthesis of Titanium dioxide nanoparticles using aqueous extract of *Pterocarpus dalbergioides* leaves A. Titanium solution B. After synthesis C. TiO_2NPs powder

The TiO_2NPs was characterized by UV spectrophotometer the range at 279.55 nm **(Figure 3)**. The UV-visible of Silver Nanoparticles (AgNPs) is 418nm.The UV-visible silver nanoparticles using ***Pterocarpus santalinus*** at 418nm (**kasi Gopinath *et al*., 2013).**

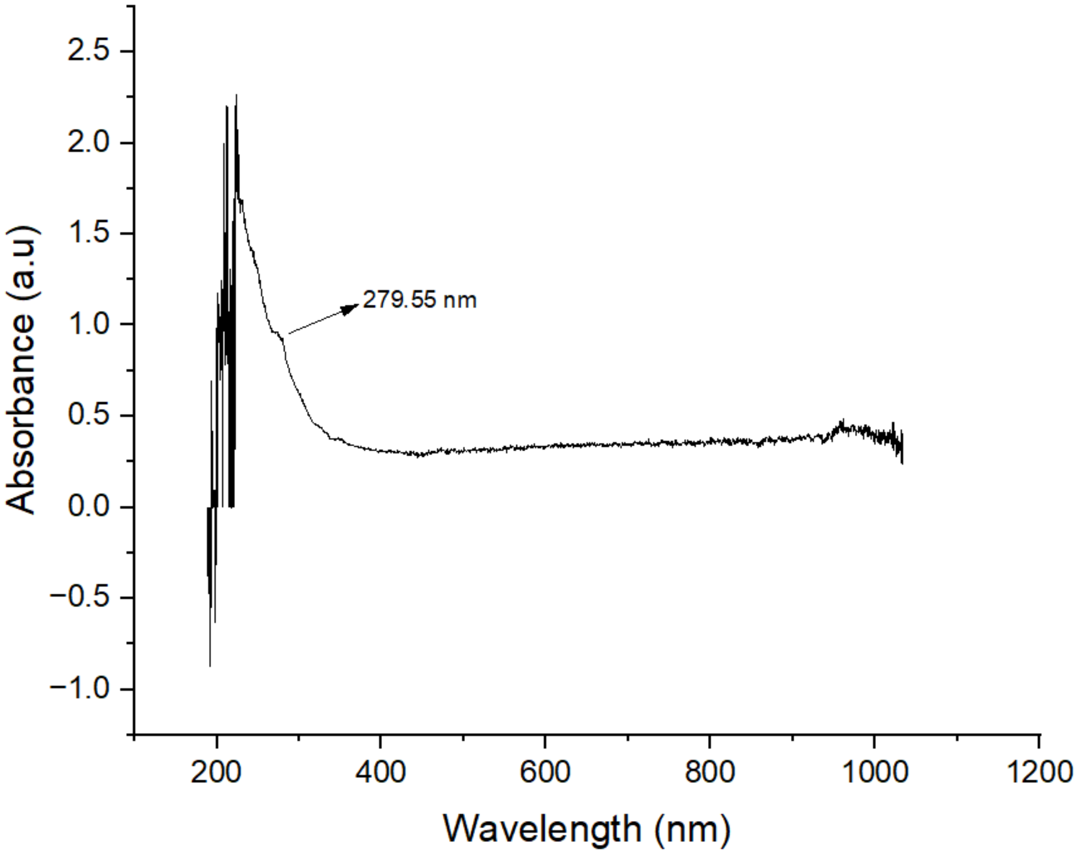

Figure 3. UV analysis of Titanium Dioxide nanoparticles

The functional group was analysed by FTIR **(Figure 4)**. FTIR analysis of Titanium dioxide nanoparticles (TiO_2NPs) synthesized revealed peaks at 1072, 1258, 1415, 1558, 2854 and 2924 cm^{-1} which correspond to functional groups C-N stretch (aliphatic amines),C-N stretch(aromatic amines),C-C stretch (in-ring) (aromatics),C-H stretch (alkanes) and C-H stretch (alkanes).The peak values of FTIR analysis of Titanium Dioxide(TiO_2 NPs) is 1109.07, 1157.29, 1203.58, 1249.87, 1284.59 and 2839.22 cm-1). The FTIR analysis of Titanium Dioxide using ***Pterocarpus indicus willd*** **(M. Rynaldi Iqbal *et al*., 2018).**

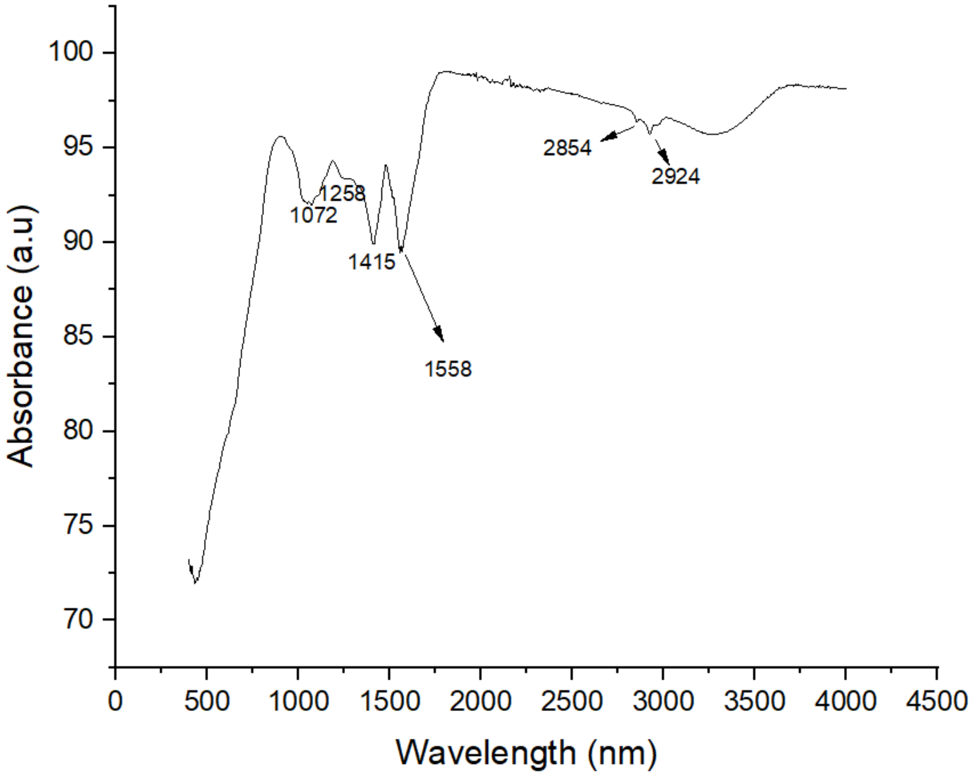

Figure 4. FTIR analysis of Titanium Dioxide nanoparticles

The X-ray diffraction (XRD) pattern of synthesized Titanium dioxide nanoparticles were showed at 25.202, 28.269, 36.840, 37.680,38.456, 47.932, 53.784, 54.975 and etc., corresponding to the lattice planes 558,154,109,163,120,190,127 and 62.8 nm are in accordance with the reported pattern (JCPDS 04-0783) which confirmed that the green synthesized TiO_2NPs are nanocrystalline **(Figure 5 and Table 1)**. The XRD analysis of Titanium Dioxide (TiO_2) TiO_2 nanoparticles is observed at 2θ of 25.356, 38.617, and 54.010.The XRD analysis of Titanium Dioxide nanoparticles using *Pterocarpus indicus* **(M. Rynaldi Iqbal et al., 2018).**

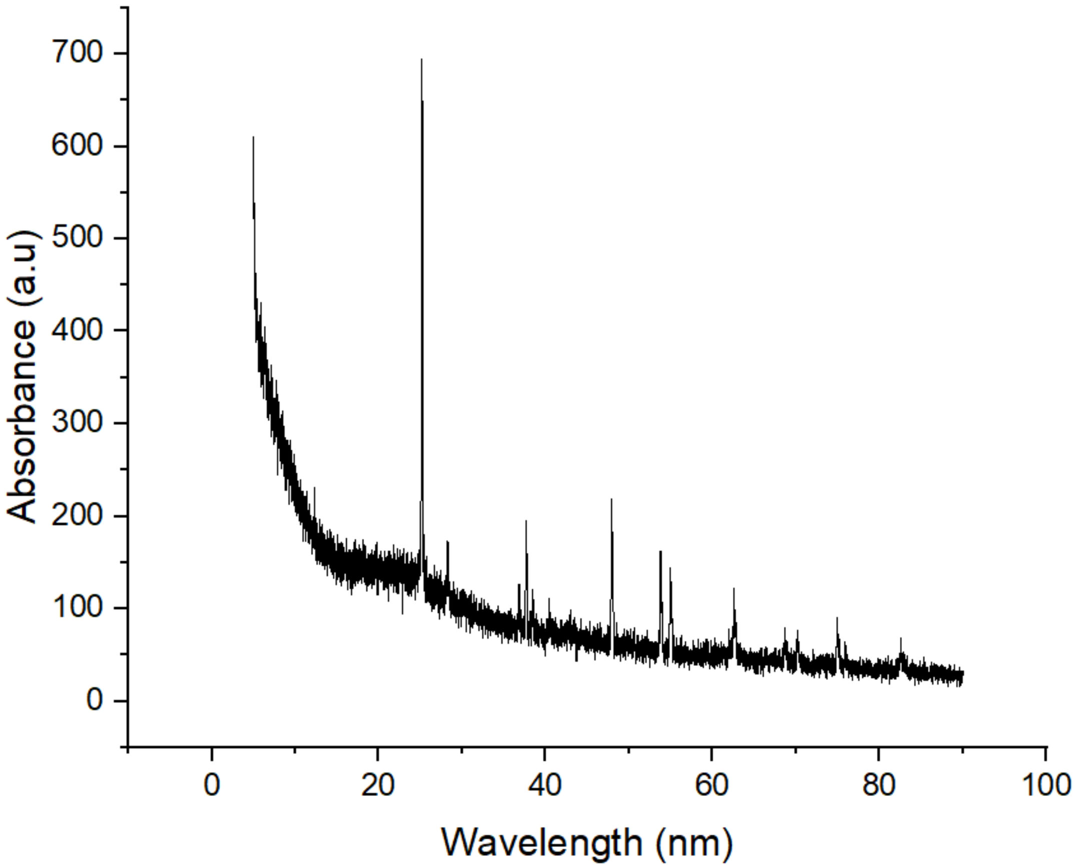

Figure 5. XRD analysis of Titanium Dioxide nanoparticles

No.	2θ, °	d, Å	Height, counts	FWHM, °	Int. I., counts °	Int. W., °	Asymmetry	Decay (ηL/mL)	Decay (ηH/mH)	Size, Å
1	25.202(4)	3.5309(6)	558(16)	0.119(4)	71.6(10)	0.165(8)	1.6(3)	0.72(8)	0.70(13)	713(27)
2	28.269(6)	3.1544(6)	154(3)	0.120(18)	7.4(7)	0.17(3)	3(3)	0.4(4)	1.5(3)	716(107)
3	36.840(17)	2.4378(11)	109(3)	0.11(3)	5.2(6)	0.16(3)	1.3(10)	1.1(6)	0.4(8)	768(176)
4	37.680(5)	2.3854(3)	163(7)	0.130(9)	12.5(6)	0.143(8)	1.3(2)	0.2(2)	0.0(3)	672(46)
5	38.456(4)	2.3390(2)	120(4)	0.055(11)	3.8(5)	0.083(7)	0.5(4)	1.5(3)	0.3(6)	1591(39)
6	47.932(7)	1.8964(3)	190(9)	0.141(9)	24.2(8)	0.188(8)	1.4(3)	0.71(17)	0.5(2)	643(40)
7	53.784(11)	1.7030(3)	127(6)	0.172(14)	16.5(7)	0.22(3)	1.1(3)	0.6(2)	0.4(3)	542(44)
8	54.975(11)	1.6689(3)	124(6)	0.164(12)	15.0(7)	0.21(3)	2.3(9)	0.1(2)	1.1(4)	570(40)
9	62.029(10)	1.4950(2)	62.8(18)	0.14(3)	2.8(5)	0.17(5)	5(6)	0.0(8)	1.5(5)	710(174)
10	62.607(12)	1.4826(3)	109(6)	0.140(13)	13.0(6)	0.21(3)	2.1(11)	0.7(2)	1.1(4)	692(66)
11	68.670(12)	1.3657(2)	70(3)	0.130(16)	5.0(5)	0.18(4)	1.8(7)	0.3(5)	1.2(7)	776(96)
12	70.197(18)	1.3397(3)	69(4)	0.161(18)	5.8(5)	0.20(4)	1.5(8)	0.6(5)	0.0(7)	630(72)
13	74.964(13)	1.26587(9)	81(5)	0.158(17)	9.8(6)	0.22(4)	1.9(9)	0.2(3)	1.3(4)	662(72)
14	75.96(3)	1.2517(5)	50(2)	0.14(3)	2.3(5)	0.16(6)	2(2)	0.0(10)	0.6(13)	737(152)
15	82.625(8)	1.16683(9)	53(3)	0.20(3)	5.1(5)	0.24(5)	5(4)	0.1(4)	1.1(5)	554(72)
16	83.073(11)	1.16167(3)	42.1(17)	0.15(4)	2.0(4)	0.18(6)	5(4)	0.1(4)	1.1(5)	722(189)

Table 1. XRD analysis of Titanium Dioxide nanoparticles

The SEM analysis was to evaluate the morphology and size of synthesized nanoparticles. SEM is most widely used technique for characterizing the nanoparticles in terms of the physical morphology of the particles. The capping of nanoparticles were preventing agglomeration of the particles and stabilizing in the medium. TiO_2NPs are showed the presence of hexagon shape and the particle size ranged from 51.7 nm to 194 nm **(Figure 6).**

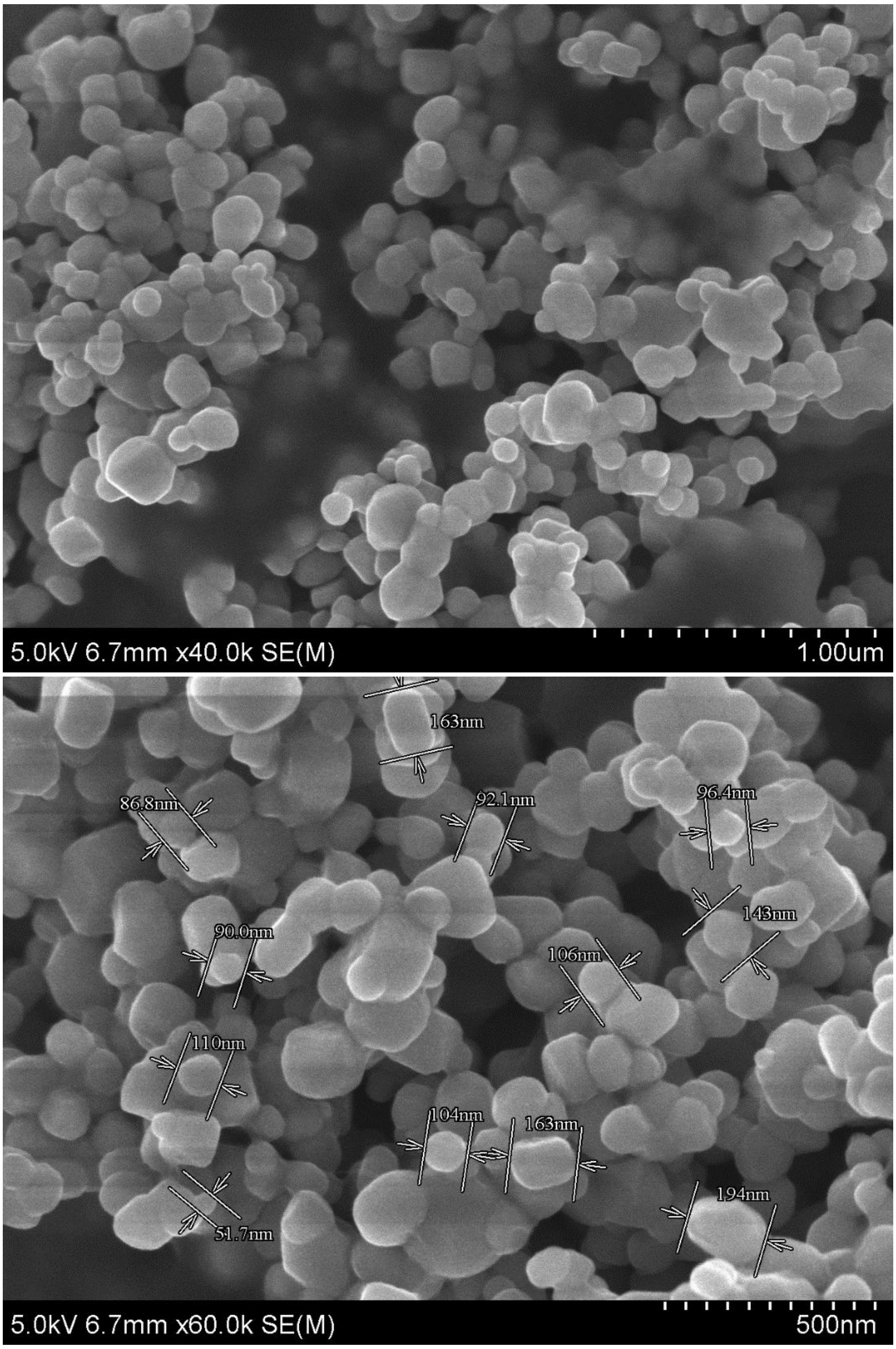

Figure 6. SEM analysis of Titanium Dioxide nanoparticles

EDAX of synthesized titanium oxide nanoparticles is shown in **(Figure 7 and Table 2)**. The spectrum confirmed the presence of a strong peak for elemental Titanium at approximately 4.5 keV.

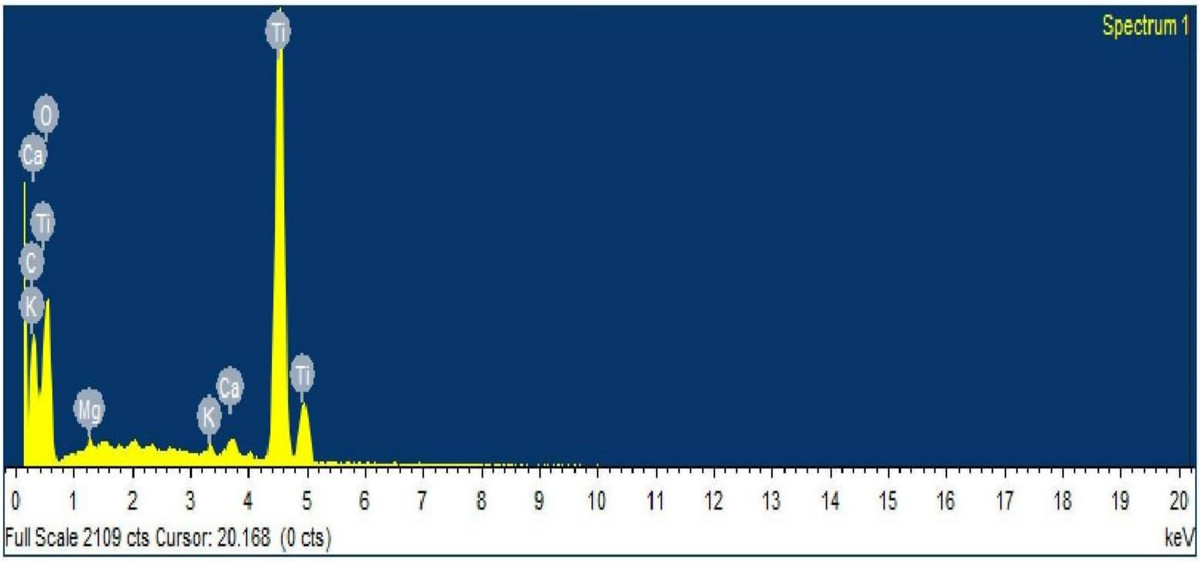

Figure 7. EDAX analysis of Titanium Dioxide nanoparticles

Element	App	Intensity	Weight%	Weight%	Atomic%
	Conc.	Corrn.		Sigma	
C K	7.16	0.9942	37.89	6.60	51.72
O K	2.56	0.3420	39.37	4.27	40.34
Mg K	0.04	0.6249	0.30	0.09	0.20
K K	0.05	1.1264	0.25	0.06	0.11
Ca K	0.11	1.0843	0.52	0.08	0.21
Ti K	3.46	0.8401	21.66	2.32	7.41
Totals			100.00		

Table 2. EDAX analysis of Titanium Dioxide nanoparticles

Anti-Diabetic activity analysis was performed by Alpha Amylase and Alpha Glucosidase method. The percentage inhibition of Alpha Amylase was exhibited at 63.6% in TiO_2NPs and 81.8% in Acarbose (standard) **(Figure 8, Table3 and Chart1).**

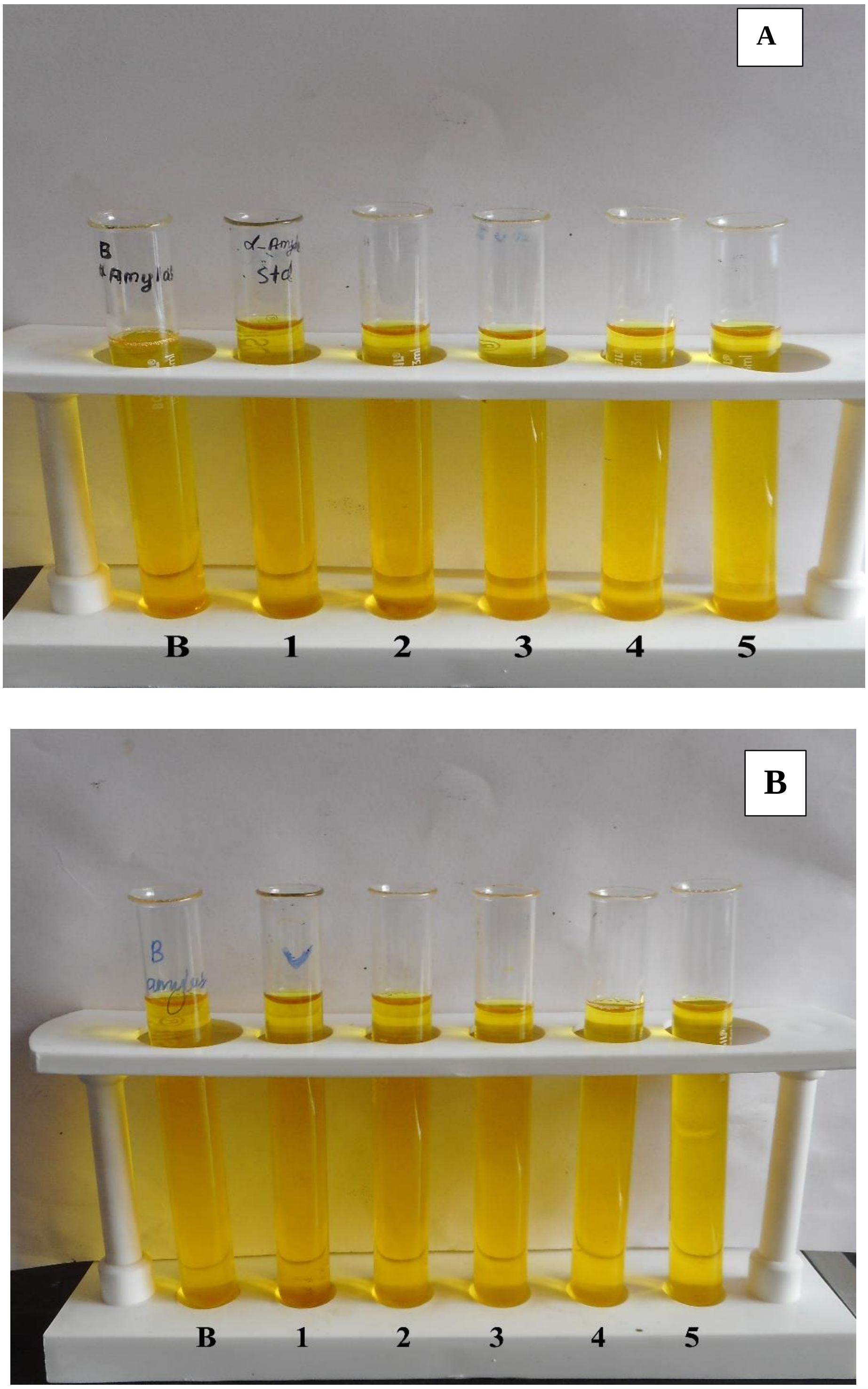

Figure 8. Anti-Diabetic activity of Alpha Amylase Assay of A. Standard (Acarbose) and B. TiO_2NPs

Concentration(µg)	Blank	100	200	300	400	500
Acarbose	0.04	0.06	0.08	0.11	0.16	0.22
% of inhibition		33.3	50	63.6	75	81.8
Concentration(µg)	blank	100	200	300	400	500

TiO_2NPs	0.04	0.05	0.07	0.08	0.10	0.11
% of inhibition		20	42.8	50	60	63.6

Table 3. Anti-Diabetic activity of Alpha Amylase Assay of A. Standard (Acarbose) and B. TiO_2NPs

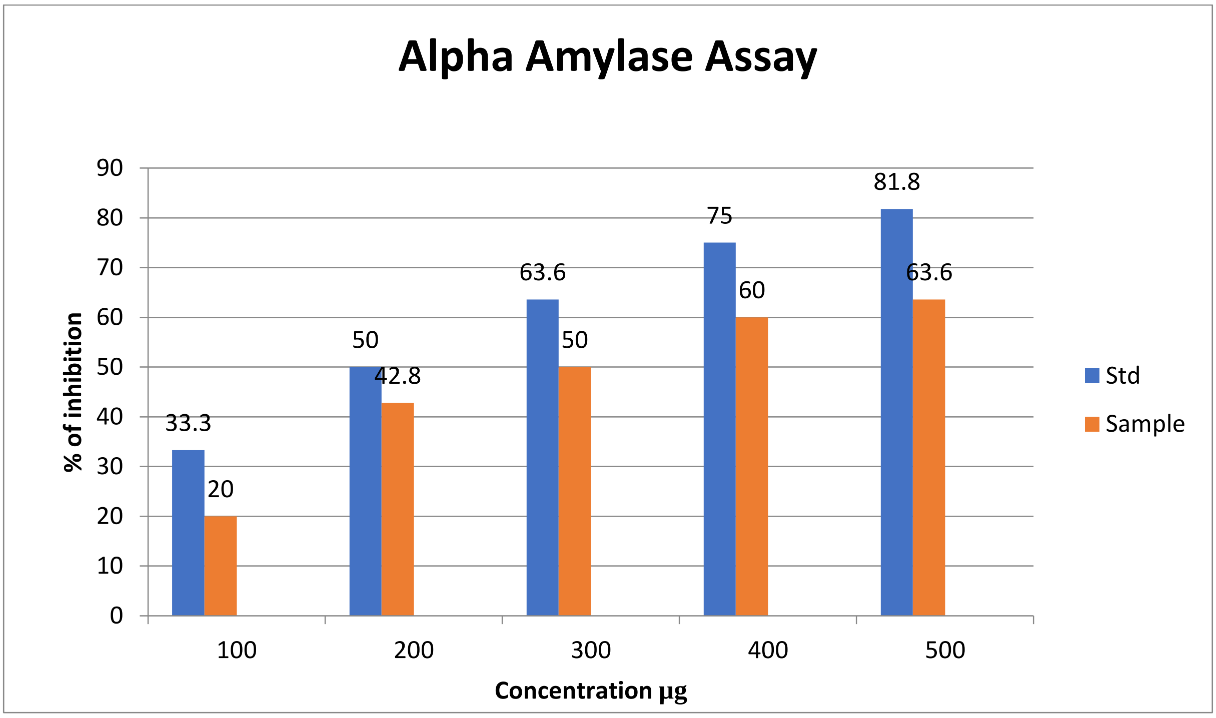

Chart 1. Anti-Diabetic activity of Alpha Amylase Assay of A. Standard (Acarbose) and B. TiO_2NPs

The percentage inhibition of Alpha Glucosidase was exhibited at 42.8% in TiO_2NPs and 84.6 % in standard Acarbose **(Figure 9, Table4 and Chart2).**

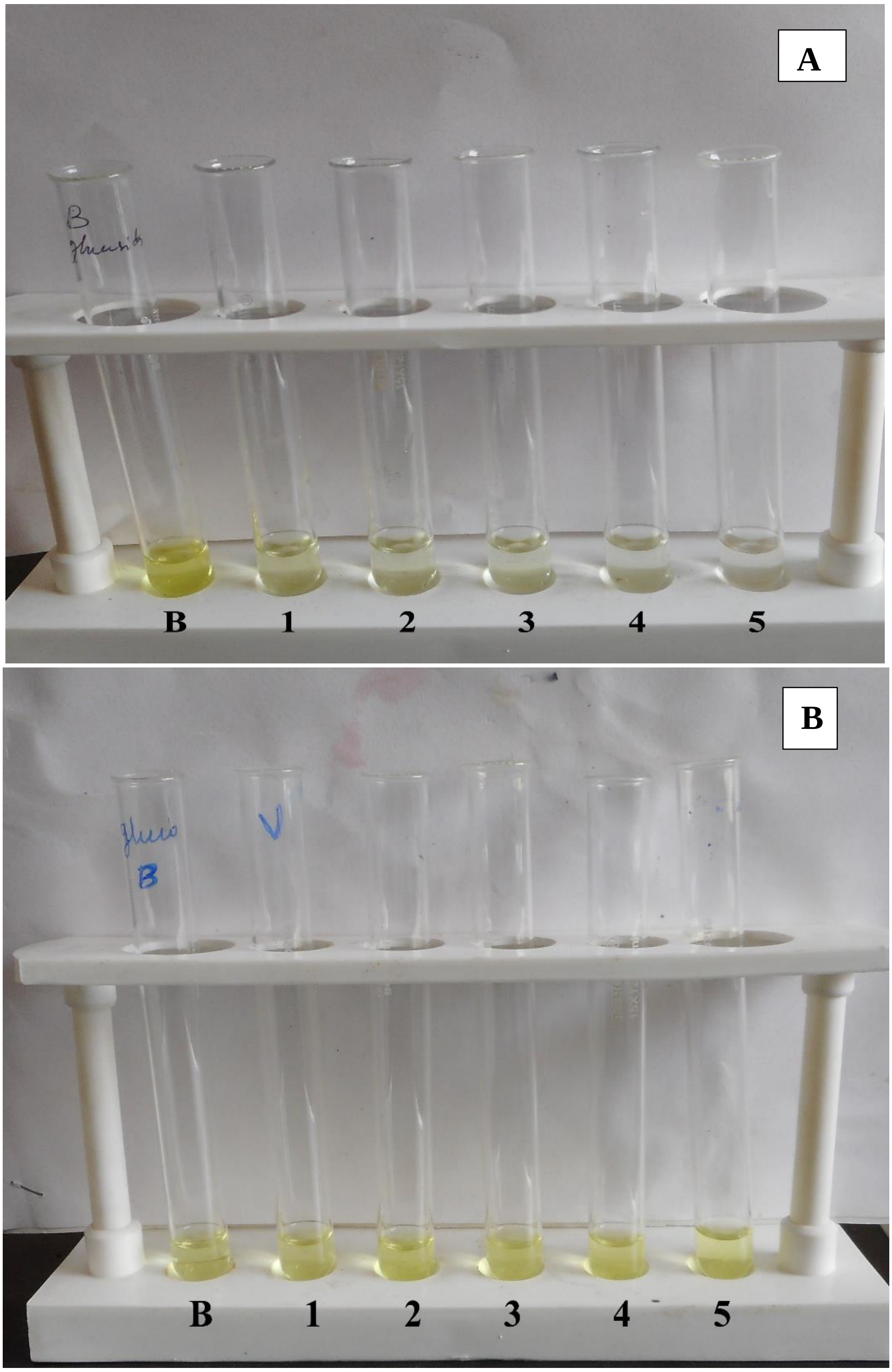

Figure 9. Anti-Diabetic activity of Alpha Glucosidase Assay of A. Standard (Acarbose) and B. TiO_2NPs

Concentration(µg)	Blank	100	200	300	400	500
Acarbose	0.13	0.11	0.09	0.07	0.04	0.02

% of inhibition		15	30.7	46.1	69.2	84.6
Concentration(µg)	Blank	100	200	300	400	500
TiO_2NPs	0.14	0.23	0.18	0.13	0.11	0.08
% of inhibition		-	-	7.1	21.4	42.8

Table 4. Anti-Diabetic activity of Alpha Glucosidase Assay of A. Standard (Acarbose) and B. TiO2NPs

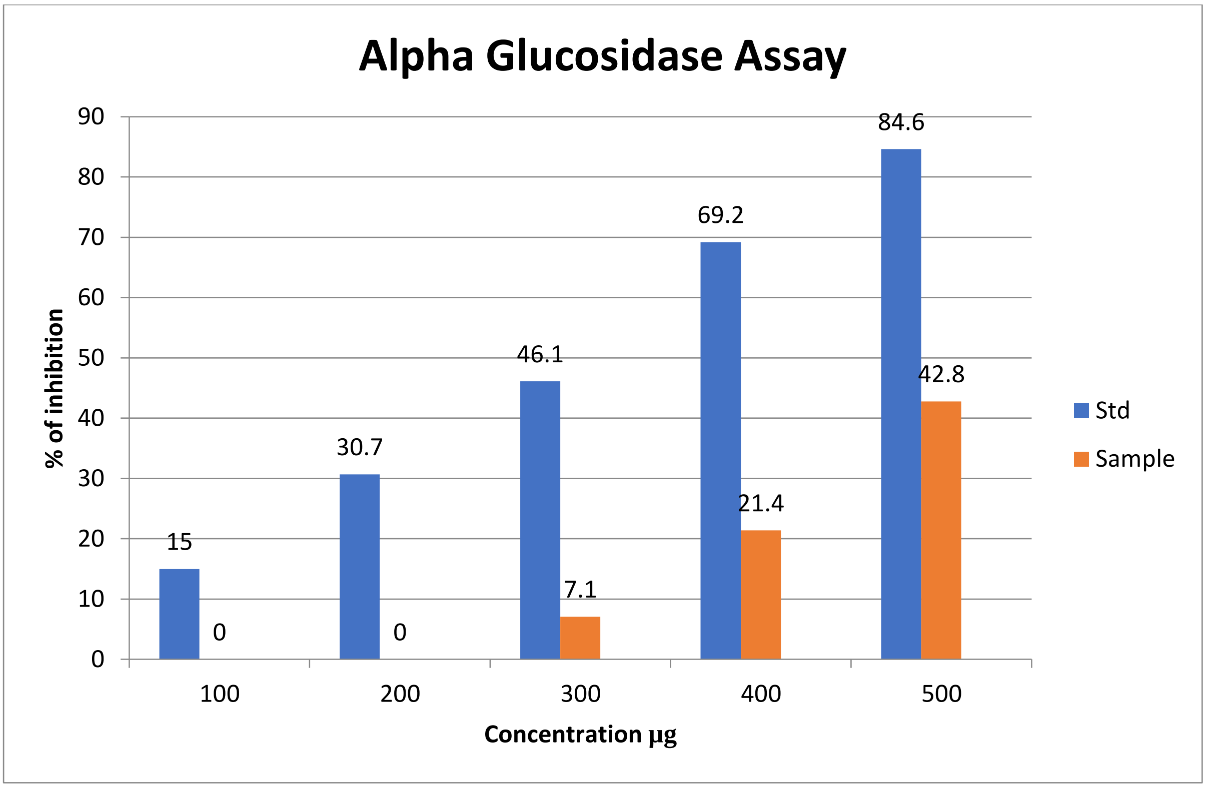

Chart 2. Anti-Diabetic activity of Alpha Glucosidase Assay of A. Standard (Acarbose) and B. TiO_2NPs

The finding results revealed that the green synthesized TiO_2NPs showed moderate antidiabetic activity.

CONCLUSION

The current study shows that TiO_2 NPs were produced utilising *Pterocarpus dalbergioides* leaves extract. This green-synthesized technique is quick, simple, convenient, takes less time, is safe for the environment, and may be used in a number of current applications.

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